BINDURA UNIVERSITY OF SCIENCE EDICATION

FACULTY OF SCIENCE EDUCATION

DEPARTMENT OF ENGINEERINGAND PHYSICS

Bachelor of Science Honours Degree in Electronic Engineering

EEE3205 - Control Engineering

Time Allowed: 3 Hours

Total Marks:100

Special Requirements: Scientific Calculator, rule, pen, pencil

INSTRUCTIONS

← MAR 2024

1. Answer any **FIVE (5) questions**
2. The question paper **contains SEVEN (7)** questions
3. Each question carries **20 marks**

1(a) With the aid of a block diagram describe elements that make up an automatic control system. [8]

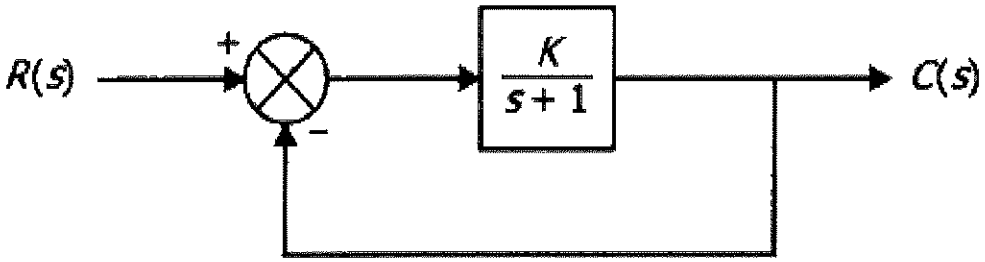
(b) Describe five advantages of closed loop control system over open loop control system. [5]

(c) State five (5) characteristics/requirements of an ideal control system. [5]

(d) Discuss the effect of positive feedback on stability of control systems. [2]

2(a) With the aid of block diagram explain the operation of an automatic electric iron. [5]

(b) Find the root locus of the unity feedback system having $G(s) = \frac{K}{s+1}$ shown below. [6]



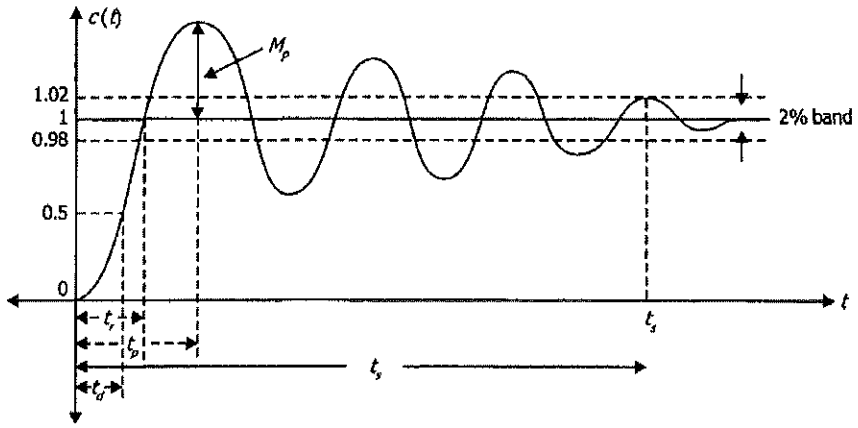
(c) Find Laplace transform of $x(t) = Sin\,\omega t$ [5]

(d) Find the Laplace Transform of the following differential equation. [4]

$$\frac{d^2x_0}{dt^2} + 3\frac{dx_0}{dt} + 2x_0 = 0$$

Initial conditions $x_0 = 4$, $\frac{dx_0}{dt} = 3$

3(a) The graph below shows Time Response specifications in symbol form. Define any four specifications shown. [8]



(b) With the aid of waveform diagrams, discuss the following time responses to step input

(i) Overdamped response [3]

(ii) Underdamped response [3]

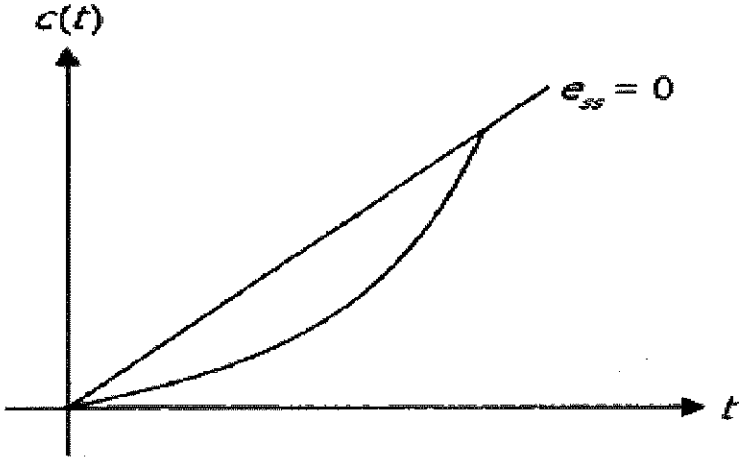
(c) With the aid of s-plane, determine whether the following systems are stable, marginally stable or unstable.

(i) -2, -5 [2]

(ii) -2,2, -j,j [2]

(iii) $x(t) = \cos \omega t.$ [2]

4(a) Use the graph below the answer the following questions



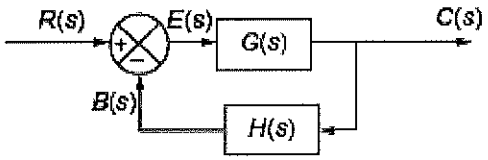
(i) State the type of input [1]

(ii) State type of system [2]

(iii) Show that, $K_V = \infty$ and e_{ss} = 0 for ramp input type 2 and higher-order systems. [3]

(b) For the closed loop control system shown below, show that [4+3]

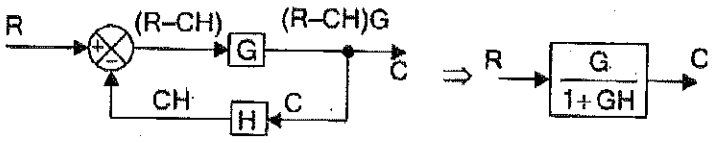
$$|M(j\omega)| = \left|\frac{G(j\omega)}{1+G(j\omega)H(j\omega)}\right| \text{ and } \angle M(j\omega) = \angle G(j\omega) - \angle[G(j\omega)\text{H}(j\omega)]$$



(c) The characteristic equation of a system is given here. Identify the poles of the system. [3]

$$10s^2 + 4s + 15 = 0$$

(d)Prove the following rule for eliminating feedback. [4]



5(a) Explore five (5) advantages of frequency response analysis over time response analysis of control systems. **[10]**

(b) With the aid of mathematical equations or diagrams where possible, define the following control systems.

(i)Linear and Non-linear control system **[2]**

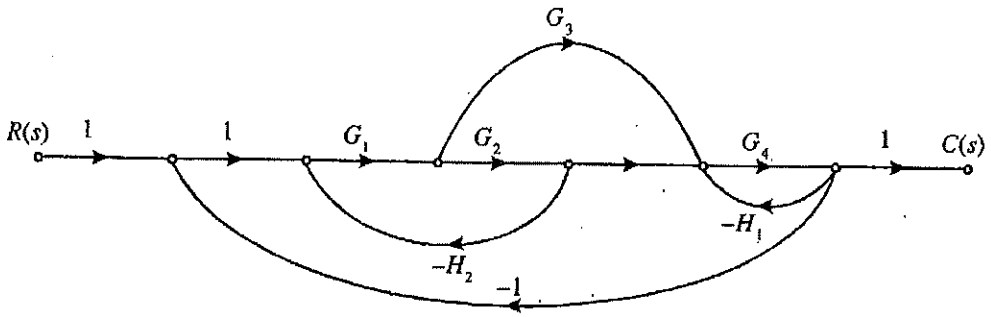
(ii)Open and closed loop control system **[2]**

(iii)Manually and Automatically operated control systems **[2]**

(iv)Time varying and Time invariant control systems **[2]**

(v)Deterministic and Non-deterministic control systems **[2]**

6 Using Mason's gain formula determine $\frac{C(s)}{R(s)}$ **[20]**



7(a) Explain the need for compensation in closed loop control systems. **[2]**

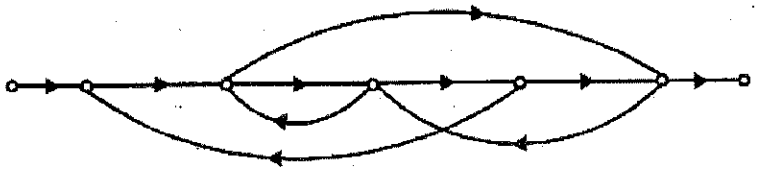
(b) Explain the following systems with aid of block diagram.

(i) Series compensated system **[4]**

(ii) Feedback compensated systems **[4]**

(c) Examine the stability of $s^4 + 6s^3 + 21s^2 + +36s + 20 = 0$ using Routh's criteria. **[8]**

(d) For the given signal flow, identify the number of forward paths and individual loops.**[2]**



The End